COURSE MANUAL

DIRECTED ASSISTANCE MODULE NO. 1:

DEVELOPING PERFORMANCE GOALS
AND A
MONITORING STRATEGY

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COURSE DESCRIPTION

DIRECTED ASSISTANCE MODULE NO. 1:

DEVELOPING PERFORMANCE GOALS AND A MONITORING STRATEGY

A. Objectives: The purpose of this course is to provide a combination of classroom and hands-on training to the staff of a public water system that treats surface water or groundwater under the direct influence of surface water. After receiving the training, the water system's staff should be able to:

1. develop a process monitoring strategy that meets regulatory requirements and provides information necessary to control the water treatment process;
2. identify the specific monitoring locations, parameters, frequencies, and laboratory methods that will be used;
3. establish performance goals and acceptable operating ranges for the parameters at each monitoring location;
4. identify the actions that will be taken when unacceptable readings occur; and
5. document the information on one or more process control monitoring forms.

B. Expertise Required:

1. **Trainer:** This Directed Assistance Module must be given by a trainer who is extremely knowledgeable about process control and monitoring practices at surface water treatment plants. The trainer must be capable of completing all of the objectives of this DAM. The TCEQ would prefer that the trainer hold a B Surface Water license..
2. **Participant:** The public water system staff attending this course should be familiar with the disinfection process and monitoring regimen used at their water treatment plant and either already hold a Water Operators license or at least have a basic understanding of potable water chlorination.

C. Facilities and Materials Required at the Training Site:

1. **Instructor:** The instructor must provide all of the materials described in the *Course Description and Instructor Guide for Directed Assistance Module No. 1.*
2. **Training Site:** This training is to be conducted at the surface water treatment plant.

D. Deliverables: During this training event, the plant staff and Instructor will produce the following documentation:

1. the completed Participant Sign Up Sheet
2. a copy of the plant schematic for the treatment plant;
3. a copy of the completed Treatment Process Monitoring Form(s);
4. a copy of the completed Recommended Action Plan Form;
5. the completed Plant Questionnaire from each participant; and
6. the completed Project Completion Form.

E. Provisional Agenda: The completion of this Directed Assistance activity is expected to take approximately five to six hours and will involve the following activities:

TABLE 1: SUMMARY OF THE PROPOSED AGENDA FOR THE MONITORING STRATEGY AND PERFORMANCE GOALS DAM

8:00 – 8:30	Introductions and overview (15 – 30 minutes)
8:30 – 9:30	Plant tour and plans review (45 – 60 minutes)
9:30 – 10:15	Monitoring locations and parameters (45 minutes)
10:15 – 10:30	Break (15 minutes)
10:30 – 11:00	Monitoring frequencies and methods (30 minutes)
11:00 – 12:00	Performance Goals and acceptable operating ranges (60 minutes)
12:00 – 1:00	Lunch (60 minutes)
1:00 – 2:00	Responding to readings outside acceptable range (45 – 60 minutes)
2: 00 – 2:30	Recommended Action Plan (20 – 30 minutes)
2:30 – 3:00	Wrap-up and Questionnaire (15 – 30 minutes)

1. Overview and objectives (15 – 30 minutes)
   The instructor will explain the purpose of the directed assistance and what needs to be accomplished before you leave.
   Participants that wish to receive Continuing Education Units (CEUs) must sign the Participant Sign Up Sheet which the instructor will provide.

2. Plant tour (45 – 60 minutes)
   The instructor will accompany the plant staff on a limited plant tour. During the plant tour, the instructor and participants will document:
   1. the general layout of the treatment units and the location of chemical feed points,
   2. the tests that the plant staff run to comply with regulatory requirements and to control the treatment process,
   3. the locations and frequencies at which samples are collected, and
   4. the laboratory methods that are used to measure the parameters.

3. Monitoring locations and parameters (45 minutes)

The instructor will:

1. *review the portions of Chapter 1 which summarize some of the samples that surface water treatment plant operators must collect to demonstrate that they are complying with minimum treatment technique requirements,*
2. *explain the importance of using sampling locations that minimize the impact of extraneous influences (e.g. proper sample tap orientation on an effluent pipe, minimum residence time in a sample supply line, etc.).*
3. *review Chapter 2, which discusses some of the monitoring locations and monitoring parameters that are often used for process control at surface water treatment plants;*
4. *help the participants evaluate the plant's current monitoring program to identify:*
    a. *critical monitoring locations in the treatment process and the water quality parameters that should be measured at each location,*
    b. *any current monitoring activities that do not seem to provide any useful process control or compliance data.*

The instructors and participants will begin completing the Process Control Monitoring Form shown in Attachment 1.

4. Break (15 minutes)

5. Monitoring frequencies and methods (30 minutes)

The instructor will:

1. *work with the plant staff to identify the appropriate frequency for monitoring each water quality parameter and the laboratory methods used to perform the measurements;*
2. *review the portions of Chapter 1 that describe minimum mandatory monitoring frequencies and methods for some of the mandatory monitoring that surface water treatment plant operators must conduct;*
3. *review Chapter 4, which an example of the monitoring frequencies and methods that one plant in Texas uses for process control samples;*
4. *help the participants establish monitoring frequencies and methods that:*
    a. *are consistent with regulatory monitoring requirements and*
    b. *take into consideration the historical range and stability of the parameters being measured.*

The instructors and participants will continue filling out the Process Control Monitoring Form.

6. Performance goals and acceptable operating ranges (60 minutes)
The instructor will:
   1. *explain the difference between performance goals and acceptable operating ranges;*
   2. *review the portions of Chapter 1 related to the minimum acceptable regulatory operating ranges;*
   3. *review Chapter 3, which contains examples of the performance goals and acceptable operating ranges for a hypothetical surface water treatment plant; and*
   4. *work with the participants to identify appropriate goals and operating ranges for each of the parameters to be monitored at the training site.*

The instructors and participants will continue filling out the Process Control Monitoring Form.

7. Lunch (60 minutes)

8. Responses to readings outside of acceptable operating ranges (45 – 60 minutes)
The instructor will:
   1. *review Chapter 3, which contains examples of the performance goals and acceptable operating ranges for a hypothetical surface water treatment plant; and*
   2. *help the participants identify appropriate responses to readings that fall outside of acceptable operating ranges identified for the training site.*

The instructors and participants will finish filling out the Process Control Monitoring Form.

9. Recommended Action Plan (20 - 30 minutes)
The instructor will:
   1. *Work with the participants and plant staff to identify specific steps that should be taken to implement an effective monitoring strategy at the treatment plant; and*
   2. *Document the steps using the Recommended Action Plan Form provided by the instructor.*

10. Wrap-up and questionnaire (15 – 30 minutes)
Each participant will complete the Plant Questionnaire provided by the instructor. The instructor will complete the DAM Completion Form.

CHAPTER 1

COMPLIANCE MONITORING REQUIREMENTS

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MANDATORY COMPLIANCE MONITORING

Sample Location	Parameter	Frequency	Equipment	Acceptable Range	Comments
Raw Water Tap (prior to any chemical addition)	Flow Rate	every flow rate change	flow meter	NA	
	Turbidity	daily	grab sample or on-line monitor	NA	
	Alkalinity	monthly	titrator	NA	
	TOC	monthly	approved or certified lab	NA	
Clarifier Effluent	TOC	monthly	approved or certified lab	NA	must meet TOC removal requirements
Individual Filter Effluent (IFE)	Turbidity (4 hrs after filter start-up)	each filter start-up	on-line monitor	≤ 0.5 NTU	only at systems serving ≥10,000 people. Also, special studies may be required for exceedance(1)
	Turbidity	depends(1)	depends(1)	≤ 1.0 NTU(1)	special studies may be required for exceedance(1)
Combined Filter Effluent (CFE)	Turbidity	depends(2)	grab sample or on-line monitor	≤ 0.3 NTU at least 95% of the time **and** ≤ 1.0 NTU all of the time	special studies may be required for exceedance(2)
At the End of Each Disinfection Zone (CT Data)	Flow Rate	daily(3)	flow meter or calculated	NA	
	Temperature(4)	daily(3)	thermometer or pH meter	NA	
	pH	daily(3)	pH meter	depends(5)	depends on disinfectant used (see notes)
	Disinfectant Residual	daily(3)	grab sample or on-line monitor	NA	must achieve at least 0.5 logs of *Giardia* inactivation **and** 2.0 logs of viral inactivation

Table continues on the following page.

Sample Location	P arameter	Frequency	Equipment	Acceptable Range	Comments
Plant Effluent (Point of Entry to Distribution)	Disinfectant Residual	depends[6]	depends[7]	≥ 0.2 mg/L (if using free chlorine) **or** ≥ 0.5 mg/L (if using chloramines)	based on type of disinfectant leaving the plant
	Chlorine Dioxide	daily	grab sample	0.8 mg/L	only required at plants that use chlorine dioxide
	Chlorite	daily	grab sample	1.0 mg/L	only required at plants that use chlorine dioxide

Notes:

(1) Systems that serve 10,000 people or more (and any plant that has more than 2 filters) must monitor IFE turbidity levels once every 15 minutes using an approved on-line turbidimeter, record the 15-minutes readings with a continuous recorder, operate within the acceptable range. A system that serves fewer than 10,000 people, has only two filters that were installed before October 1, 200, and does not have IFE turbidimeters must use daily grab samples and do not have to operate within the acceptable range. Any plant that continuously monitors IFE turbidity levels must investigate the cause of any filter exceedance.

(2) CFE turbidity levels may be monitored at the clearwell inlet or outlet. If the plant is required to have on-line IFE monitors and recorders, CFE sampling frequency depends on system size . . . those serving fewer than 500 people may monitor once per day or every four hours while those serving 500 people or more must monitor every four hours. Plants that are staffed around the clock may use either grab samples or on-line turbidimeters while plants that are not staffed continuously must use on-line turbidimeters and recorders to collect data when the plant operates and operators are not present.

Plants that do not have IFE turbidimeters and recorders, must monitor CFE turbidity levels once every 15 minutes using an approved on-line turbidimeter, record all of the 15-minutes readings with a continuous recorder, report all of their readings, and investigate the cause of any consecutive readings above 1.0 NTU.

(3) CT data must be collected after the plant has been operating at the peak flow rate that occurs during the day. This may require multiple samples to be collected if the operators vary the flow rate.

(4) Operators may use the raw water temperature for all of the CT calculations.

(5) The maximum and minimum allowable pH level in each disinfection zone depends on the type of disinfectant being used. For free chlorine disinfection credit (for *Giardia*), the pH must be no greater than 9.0. For chloramines, pH must be between 6.0 and 9.5. For chlorine dioxide, pH must not drop below 6.0.

(Notes continue on the next page)

(6) Sampling frequency depends on system size. See Table below.

System Size by Population	Samples/day
≤ 500	1
501 to 1,000	2
1,001 to 2,500	3
2,501 to 3,300	4
> 3,300	every 15 minutes

(7) All systems serving more than 3,300 people and any plant that is not staffed continuously must use an on-line analyzer and recorder to collect data when the plant operates and operators are not present. Plants that are staffed around the clock may use either grab samples or an approved on-line chlorine residual analyzer if the system serves no more than 3,300 people.

CHAPTER 2

TYPICAL PROCESS CONTROL MONITORING POINTS AND PARAMETERS

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TYPICAL MONITORING POINTS AND PROCESS CONTROL PARAMETERS

Sample Location	Parameter	Frequency	Equipment
Raw Water Meter	Flow Rate	Once per shift	Ultrasonic meter
Raw Water Tap (10 minutes after startup)	Turbidity	Once per shift	2100N
	pH	Daily	pH meter
	Alkalinity	Daily	titration
	TOC	First Tuesday of every month	reference lab
	Temperature	Once per shift	pH meter
	Chlorine Dioxide (D1)	Once per shift	Amperometeric titrator
Rapid Mix Effluent (10 minutes after startup)	pH (coagulation control)	Once per shift & every time alum dose changes	pH meter
	Chloramine (D2 application point)	before and after every chlorine or ammonia dose change	DPD & colorimeter
Flocculator; 3rd Stage (30 minutes after startup)	Floc Appearance	Every 4 hours	visual
	Floc Settling Rate	Daily & every time alum dose changes	Jar test jar
Rectangular Sedimentation Basin Effluent (3 hours after startup)	Floc Appearance	Every 4 hours	visual
	Turbidity	Once per shift & every time alum dose changes	2100N
	pH (D2A)	once per shift & before and after every chlorine or ammonia dose change	pH meter
	Chloramine (D2A)	once per shift & before and after every chlorine or ammonia dose change	DPD & colorimeter
Solids Contact Clarifier Effluent (1 hour after startup)	Floc Appearance	Every 4 hours	visual
	Floc Settling Rate (floc chamber)	Daily & every time alum dose changes	Jar test jar
	Solids Concentration (floc chamber)	Daily	Imhoff Cone
	Sludge Blanket cond.	Every 4 hours	visual
	Turbidity	Once per shift & every time alum dose changes	2100N
	pH (D2B)	once per shift & before and after every chlorine or ammonia dose change	pH meter

Sample Location	Parameter	Frequency	Equipment
	Chloramine (D2B)	once per shift & before and after every chlorine or ammonia dose change	DPD & colorimeter
Splitter Box Effluent (10 minutes after startup)	pH (pH adjustment point)	before and after every chlorine or ammonia dose change	pH meter
	Chloramine (D3 application point)	before and after every chlorine or ammonia dose change	DPD & colorimeter
Individual Filter Effluent	Turbidity	every 15 minutes	1720D
	Turbidity	Daily (for comparison) (30 minutes after startup)	1720D & 2100N
	Turbidity	4 hours after startup	1720D or 2100N
	Flow Rate	every time a D3 sample is collected	venturi meter
	TOC	First Tuesday of every month	reference lab
Combined Filter Effluent	Turbidity	every 15 minutes	1720D
	pH (D3)	once per shift & before and after every chlorine or ammonia dose change	pH meter
	Chloramine (D3)	once per shift & before and after every chlorine or ammonia dose change	DPD & colorimeter
Clearwell Influent	Chloramine (D4 application point)	before and after every chlorine or ammonia dose change	DPD & colorimeter
Clearwell Effluent	pH (D4)	once per shift & before and after every chlorine or ammonia dose change	pH meter
	Chloramine (D4)	once per shift & before and after every chlorine or ammonia dose change	DPD & colorimeter
	pH	Daily	pH meter
	Alkalinity	Daily	titration
	Turbidity	once per shift	2100N
	Chlorine dioxide	Daily	Amp. Titrator
	Chlorite	Daily	Amp. Titrator

CHAPTER 3

EXAMPLES OF PERFORMANCE GOALS AND ACCEPTABLE OPERATING RANGES FOR A HYPOTHETICAL PLANT

DIRECTED ASSISTANCE MODULE NO. 1
DEVELOPING PERFORMANCE GOALS AND A MONITORING STRATEGY

EXAMPLES OF PERFORMANCE GOALS AND ACCEPTABLE RANGES FOR A HYPOTHETICAL PLANT

Sample Location	Parameter	Performance Goal	Acceptable Range
Raw Water Meter	Flow Rate	None	None
Raw Water Tap (10 minutes after startup)	Turbidity	None	< 150 NTU
	pH	7.2 – 7.6	7.2 – 7.6
	Alkalinity	> 145 mg/L	None
	TOC	None	None
	Temperature	None	None
	Chlorine Dioxide (D1)	0.25 mg/L	0.10 – 0.60 mg/L
Rapid Mix Effluent (10 minutes after startup)	pH (coagulation control)	6.9 – 7.2	6.5 – 7.5
	Chloramine (D2 application point)	1.2 – 1.5 mg/L	0.3 – 2.5 mg/L
Flocculator; 3rd Stage (30 minutes after startup)	Floc Appearance	well-defined floc with clear water between floc particles	Unacceptable cloudy water
	Floc Settling Rate	at 10 cm: 2.0 – 3.5 NTU after 15 minutes	at 10 cm: < 5.0 NTU after 15 minutes
Rectangular Sedimentation Basin Effluent (3 hours after startup)	Floc Appearance	clear water no more than 30 feet from flocculator wall	Unacceptable visible floc wall extending past first sludge rake
	Turbidity	< 2.0 NTU	< 5.0 NTU
	pH (D2A)	7.2 – 7.4	None
	Chloramine (D2A)	0.6 – 1.5 mg/L	0.2 – 2.0 mg/L
Solids Contact Clarifier Effluent (1 hour after startup)	Floc Appearance	well-defined floc with clear water between floc particles	Unacceptable cloudy water
	Floc Settling Rate (floc chamber)	at 10 cm: 1.5 – 3.0 NTU after 15 minutes	at 10 cm: < 3.5 NTU after 15 minutes
	Solids Concentration (floc chamber)	8 – 12 %	6% – 19%
	Sludge Blanket Appearance	compact blanket surface no more than 2 feet above bottom of skirt	Unacceptable fluffy blanket surface that comes closer than 3 feet to the launderer troughs
	Turbidity	< 1.0 NTU	< 3.5 NTU
	pH (D2B)	7.2 – 7.4	None

Sample Location	Parameter	Performance Goal	Acceptable Range
	Chloramine (D2B)	0.8 – 1.5 mg/L	0.5 – 2.0 mg/L
Splitter Box Effluent (10 minutes after startup)	pH (pH adjustment point)	7.4 – 7.6	7.4 – 8.0
	Chloramine (D3 application point)	1.8 – 2.0 mg/L	1.0 – 3.0 mg/L
Individual Filter Effluent	Turbidity (15 minute)	< 0.80 NTU	< 0.80 NTU (TCEQ limit = 1.0 NTU)
	Turbidity (4 hour)	< 0.20 NTU	< 0.30 NTU (TCEQ limit = 0.5 NTU)
	Turbidity Spike	< 0.40 NTU	< 0.80 NTU
	Flow Rate	None	None
	TOC	None	None
Combined Filter Effluent	Turbidity	< 0.25 NTU	< 0.35 NTU
	pH (D3)	7.4 – 7.6	7.4 – 8.0
	Chloramine (D3)	1.2 – 1.5 mg/L	0.4 – 2.0 mg/L
Clearwell Influent	Chloramine (D4 application point)	1.5 – 1.8 mg/L	1.5 – 2.5 mg/L
Clearwell Effluent	pH (D4)	7.4 – 7.6	7.4 – 8.0
	Chloramine (D4)	1.5 – 1.8 mg/L	1.5 – 2.5 mg/L
	Alkalinity	> 120 mg/L	None
	Turbidity	< 0.25 NTU	< 0.35 NTU
	Chlorine dioxide	BDL	<0.30 mg/L
	Chlorite	< 0.5 mg/L	<0.8 mg/L

CHAPTER 4

TYPICAL RESPONSES TO READINGS OUTSIDE OF ACCEPTABLE RANGES

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TYPICAL RESPONSES TO READINGS OUTSIDE OF ACCEPTABLE RANGES

Sample Location	Parameter	Acceptable Range	Response to Unacceptable Reading
Raw Water Meter	Flow Rate	None	NA
Raw Water Tap (10 minutes after startup)	Turbidity	< 150 NTU	See Note 1
	pH	7.2 – 7.6	Contact chief operator
	Alkalinity	None	NA
	TOC	None	NA
	Temperature	None	NA
	Chlorine Dioxide (D1)	0.10 – 0.60 mg/L	Contact chief operator
Rapid Mix Effluent (10 minutes after startup)	pH (coagulation control)	6.5 – 7.5	Contact chief operator
	Chloramine (D2 application point)	0.3 – 2.5 mg/L	See Note 2
Flocculator; 3rd Stage (30 minutes after startup)	Floc Appearance	Unacceptable cloudy water	See Note 1
	Floc Settling Rate	at 10 cm: < 5.0 NTU after 15 minutes	See Note 1
Rectangular Sedimentation Basin Effluent (3 hours after startup)	Floc Appearance	Unacceptable visible floc wall extending past first sludge rake	See Note 1
	Turbidity	< 5.0 NTU	See Note 1
	pH (D2A)	None	NA
	Chloramine (D2A)	0.2 – 2.0 mg/L	See Note 3
Solids Contact Clarifier Effluent (1 hour after startup)	Floc Appearance	Unacceptable cloudy water	See Note 1
	Floc Settling Rate (floc chamber)	at 10 cm: < 3.5 NTU after 15 minutes	See Note 1
	Solids Conc. (floc chamber)	6% – 19%	Adjust sludge blowdown duration until desired solids concentration is reestablished
	Sludge Blanket Appearance	Unacceptable fluffy blanket surface that comes closer than 3 feet to the launderer troughs	See Note 1
	Turbidity	< 3.5 NTU	See Note 1
	pH (D2B)	None	NA

Sample Location	Parameter	Acceptable Range	Response to Unacceptable Reading
	Chloramine (D2B)	0.5 – 2.0 mg/L	See Note 3
Splitter Box Effluent (10 minutes after startup)	pH (pH adjustment point)	7.4 – 8.0	1) Adjust caustic feed rate by 5% and repeat test
	Chloramine (D3 application point)	1.0 – 3.0 mg/L	See Note 2
Individual Filter Effluent	Turbidity (15 minute)	< 0.80 NTU	Backwash Filter
	Turbidity (4 hour)	< 0.30 NTU	1) Backwash (or re-backwash) Filter 2) Leave filter off-line for 45 minutes then slowly return to service
	Turbidity Spike	< 0.80 NTU	1) Leave filter off-line for 45 minutes then slowly return to service 2) Re-backwash if no improvement
	Flow Rate	None	NA
	TOC	None	NA
Combined Filter Effluent	Turbidity	< 0.35 NTU	See Note 4
	pH (D3)	7.4 – 8.0	See Note 5
	Chloramine (D3)	0.4 – 2.0 mg/L	See Note 3
Clearwell Influent	Chloramine (D4 application point)	1.5 – 2.5 mg/L	See Note 2
Clearwell Effluent	pH (D4)	7.4 – 8.0	Contact chief operator
	Chloramine (D4)	1.5 – 2.5 mg/L	See Note 3
	Alkalinity	None	NA
	Turbidity	< 0.35 NTU	See Note 4
	Chlorine dioxide	<0.30 mg/L	Contact chief operator
	Chlorite	<0.8 mg/L	Contact chief operator

Notes:

Note 1: This note applies under any of the following circumstances:

1) The raw turbidity level exceeds 150 NTU;
2) The settled water turbidity at the effluent of the Sedimentation Basin or the Solids Contact Clarifier exceeds acceptable levels; or
3) The floc in either flocculation unit does not appear to be well-formed or is not settling properly.

Under those conditions, the operator on duty shall:

1) Calculate the current coagulant dose;
2) Run a jar test to determine the desired dose; and
3) Contact the chief operator.

Note 2: This note applies if the disinfectant residual at the point of application is not within the acceptable range. Under those conditions, the operator on duty shall:

1) Calculate the current chlorine and ammonia doses;
2) Determine the desired chlorine and ammonia feed rates; and
3) Make the necessary changes and resample.

Note 3: This note applies if the disinfectant residual at the end of the disinfection zone is not within the acceptable range. Under those conditions, the operator on duty shall:

1) Calculate current chlorine and ammonia doses;
2) Measure the chloramine residual at the point of application;
3) Determine what the new chloramine residual needs to be;
4) Calculate the desired chlorine and ammonia feed rates; and
5) Make the necessary changes and resample at the point of application.

Note 4: This note applies if the turbidity level at the CFE or clearwell effluent sampling points are above acceptable levels. Under those conditions, the operator on duty shall:

1) Determine if the CFE and clearwell effluent turbidity levels are lower than the IFE turbidity levels. (If they are, contact the chief operator. If they are not, then proceed to step b).
2) Measure the pH, Iron, Manganese, and Aluminum levels at the sample site, and then contact the chief operator.

Note 5: This note applies if the pH in the combined filter effluent (the sampling point for Disinfection Zone D3) is not within acceptable levels. In this case, the operator on duty shall:

1) Test the pH of the Splitter Box effluent.
2) If the pH of the Splitter Box Effluent is acceptable, contact the Chief Operator to inform him of a possible problem in Disinfectant Zone D3.
3) If the pH of the Splitter Box effluent is unacceptable, make the necessary adjustments to achieve an acceptable pH through Disinfectant Zone D3.